CLAIMS

1. An apparatus for manufacturing a bonded substrate, comprising:

a treatment chamber;

first and second holding units, which oppose each other in the treatment chamber, wherein the first and second holding units respectively hold first and second substrates, and at least one holding unit generates pressure to attract the associated substrate through vacuum;

a vacuum pump, which depressurizes the treatment chamber; and

a control device, which controls the treatment chamber, the first and second holding units, and the vacuum pump; wherein the control device instructs each holding unit to attract the associated substrate through vacuum, depressurizes the treatment chamber, and substantially equalizes the pressure applied by at least one holding unit with the pressure in the treatment chamber.

2. The apparatus according to claim 1, wherein each holding unit includes another holding device for holding the associated substrate, wherein the control device instructs the another holding device to hold the associated substrate and turns off vacuum attraction of the at least one holding unit.

3. The apparatus according to claim 2, wherein the another holding device includes an electrostatic chuck for electrostatically attracts the associated substrate.

4. The apparatus according to claim 3, wherein the control device substantially equalizes the pressure applied by at least one holding unit with the pressure in the treatment chamber when or after each electrostatic chuck starts to

electrostatically attract the associated substrate.

5. The apparatus according to claim 1, wherein each holding unit includes an attraction side, and the attraction side includes a first groove for generating the pressure and a second groove that extends in the same direction as the first groove.

6. The apparatus according to claim 5, wherein, when each attraction side attracts the associated substrate, the first groove and a portion of the second groove are covered by the substrate.

7. The apparatus according to claim 3, wherein each electrostatic chuck includes:

a dielectric layer, which includes a side, wherein the dielectric layer electrostatically attracts the associated substrate;

an electrode, which is embedded at a predetermined depth of the dielectric layer, wherein an attraction voltage is supplied to the electrode; and

a conductive connector, which is connected to the side of the dielectric layer and supplies a separation voltage to the dielectric layer.

8. The apparatus according to claim 7, further comprising a conductive body, which is located on a surface of the dielectric layer, wherein a portion of the conductive body corresponds to a component forming area on a first side of each substrate, and the control device grounds the conductive body or supplies a predetermined separation voltage to the conductive body for separating each substrate from the associated holding unit.

9. The apparatus according to claim 7, further comprising a conductive body, which is located on a surface of the dielectric layer, wherein a portion of the conductive body corresponds to a component forming area on a first side of each substrate, and the control device electrically connects the conductive body to a second side of the substrate opposite to the first side for separating each substrate from the associated holding unit.

10. The apparatus according to claim 1, wherein the first and second substrates are bonded together with a seal including a photo-curing adhesive, the apparatus further comprising:

a hardening device, which opposes one side of at least one substrate, wherein the hardening device includes an irradiation source that irradiates light for hardening the adhesive; and

an irradiation sensor, which is connected to the control device, wherein the irradiation sensor measures an amount of the light irradiated to the first and second substrates;

wherein the control device controls an interval between the light source and the substrates in accordance with the measurement of the irradiation sensor.

11. The apparatus according to claim 10, wherein:

the first or second holding unit holds the first and second substrates that are bonded together; and

the hardening device includes a device for cooling the holding unit that holds the bonded substrates.

12. The apparatus according to claim 11, wherein the holding unit that holds the bonded substrates is formed of a material that readily absorbs light.

13. The apparatus according to claim 1, further comprising a liquid drip device, which drips a liquid on the first substrate, wherein the liquid drip device includes:

a syringe, which retains the liquid, wherein the syringe has a nozzle through which the liquid is discharged when pressure is applied to the liquid; and

a drip amount equalizing device, which is located in the syringe.

14. The apparatus according to claim 13, wherein the drip amount equalizing device includes at least one of:

a rotary valve, which is formed in the syringe, wherein the rotary valve selectively blocks movement of the liquid;

a heater, which maintains the temperature of the liquid at a constant level;

a blower, which is located in the vicinity of the nozzle, wherein the blower blows away the liquid adhered to the nozzle; and

a suction inlet, which is located in the vicinity of the nozzle, wherein the suction inlet draws the liquid adhered to the nozzle.

15. The apparatus according to claim 14, wherein the suction inlet opposes the blower.

16. The apparatus according to claim 13, wherein the liquid drip device includes a plunger that presses the liquid from the syringe, the drip amount equalizing device includes a measurement device that measures an amount of the liquid dripped from the syringe, and the control device controls an operation amount of the plunger in accordance with a measurement result of the measurement device.

17. The apparatus according to claim 1, wherein the

first and second substrates respectively include first and second alignment marks, the apparatus further comprising:

a first alignment device, which aligns the first and second substrates that are attracted to the associated holding units, wherein the alignment device includes:

an image pickup device, which is connected to the control device, wherein the image pickup device acquires an image of the first and second alignment marks; and

a movement mechanism, which is connected to the control device, wherein the movement mechanism moves the first and second holding units.

18. The apparatus according to claim 17, wherein:

before transporting the first and second substrates to the treatment chamber, the control device transports a third substrate with a third alignment mark formed at a position corresponding to the first and second alignment marks to the treatment chamber and acquires an image of the third alignment mark with the image pickup device to store the position of the third alignment mark in a field of view of the image pickup device; and

the first alignment device acquires an image of each of the first and second alignment marks with the image pickup device and corrects the position of the image pickup device in accordance with the difference between the position of each of the first and second alignment marks in the field of view of the image pickup device and the position of the third alignment mark in the field of view of the image pickup device.

19. The apparatus according to claim 17, wherein:

the image pickup device is one of a plurality of image pickup devices that are located at positions corresponding to the alignment marks;

each image pickup device has a first lens with a relatively small power and a second lens with a relatively large power; and

the first alignment device aligns the first and second substrates in a stepped manner using the first and second lenses before the substrates are bonded together.

20. The apparatus according to claim 19, further comprising a second alignment device, wherein the second alignment device aligns the first and second substrates before the substrates are transported to the treatment chamber, and the second alignment device has a third lens with a power smaller than that of the second lens.

21. The apparatus according to claim 19, wherein:

the control device stores a first reference position in the treatment chamber and a second reference position in the second alignment device; and

the control device detects an offset amount between the position of each of the first and second substrates in the second alignment device and the second reference position, compensates the offset amount, and transports the first or second substrate from the second reference position to the first reference position.

22. The apparatus according to claim 17, wherein:

the treatment chamber includes a first section and a second section that are separable from each other;

the first holding unit is secured to the first section;

the second holding unit is secured to the second section;

the first section moves during alignment; and

the second section moves integrally with the first section after the treatment chamber is depressurized.

23. The apparatus according to claim 1, further comprising a pressing device, which actuates the first and second holding units to press the first and second substrates to each other, wherein the pressing device includes:

a support, which is located in the exterior of the treatment chamber, wherein the support supports one of the holding units such that the supported holding unit moves relative to the holding unit not supported by the support;

a support arm, from which the support is suspended;

a first actuator, which selectively raises and lowers the support arm; and

a load cell, which is located between the support arm and the support, wherein the load cell detects the total weight of the support and the supported holding unit when the pressure in the treatment chamber is substantially at the atmospheric level, the load cell detects the sum of the atmospheric pressure acting on the supported holding unit through the support and the total weight of the support and the supported holding unit when the treatment chamber is depressurized, the sum decreases if the treatment chamber is depressurized and the first and second substrates are pressed to each other, and the control device computes a pressure acting on each substrate to press the first and second substrates to each other in accordance with a decrease of the sum.

24. The apparatus according to claim 23, wherein the supported holding unit is located above the holding unit not supported by the support, the apparatus further comprising:

a second actuator, which is located in the support arm, wherein the second actuator applies a bonding pressure to the first and second substrates through the supported holding unit, the bonding pressure acts on the load cell through the support arm, the load cell detects the sum of the total weight of the support and the supported holding unit, the atmospheric

pressure, and the bonding pressure when the first and second substrates are pressed to each other, and the control device controls the bonding pressure of the second actuator in accordance with the sum.

25. The apparatus according to claim 24, wherein:

the first and second substrates are bonded as one body after being pressed to each other;

the control device separates the supported holding unit from the second substrate and the holding unit not supported by the support after pressing the first and second substrates to each other, such that the bonded substrates are attracted to the holding unit not supported by the support; and

subsequently the control device opens the treatment chamber to the atmospheric air.

26. The apparatus according to claim 25, further comprising at least one transport table, wherein the transport table receives the bonded substrates from the holding unit not supported by the support and transports the substrates to a hardening device for hardening the seal.

27. The apparatus according to claim 26, wherein the apparatus controls the time that elapses after the first and second substrates are bonded together until the hardening device irradiates light to an adhesive agent.

28. The apparatus according to claim 25, further comprising:

a plurality of transport trays, each of which has a flat plate with a predetermined flatness; and

a transfer arm, which transfers the bonded substrates from the holding unit not supported by the support to one transport tray, wherein the transport tray transports the

bonded substrates to the hardening device;

wherein the control device measures the time for each transport tray after the first and second substrates are bonded together, and the control device transports each transport tray to a hardening device to harden an adhesive that bonds the first and second substrates together after a predetermined time.

29. The apparatus according to claim 28, wherein a misalignment amount between the first and second substrates after the adhesive is hardened is stored as a transport information for each transport tray, and the first and second substrates are aligned in accordance with the transport information.

30. The apparatus according to claim 28, further comprising an inspecting device, wherein the inspecting device inspects an offset amount between the first and second substrates after the adhesive agent is hardened, and the control device compensates the offset amount for transporting another pair of substrates for a subsequent bonding cycle to the hardening device.

31. The apparatus according to claim 30, wherein the inspecting device is located on a transport path of the first and second substrates.

32. The apparatus according to claim 1, further comprising a bending correction mechanism, which is installed in at least one holding unit, wherein the bending correction mechanism corrects bending of the substrate to be attracted to the holding unit.

33. The apparatus according to claim 1, wherein one of

the holding units is separable to a chuck portion that holds one of the substrates and a base stage that supports the chuck portion, and wherein the bonded substrates are transported together with the chuck portion.

34. The apparatus according to claim 1, further comprising:

a slider, which transports the first and second substrates as a pair to the treatment chamber; and

a transport robot, which receives the first and second substrates together from the slider, wherein each substrate has an identifying information, and the transport robot reverses the first or second substrate in accordance with the identifying information and returns the reversed substrate to the slider.

35. The apparatus according to claim 1, further comprising a transport device, wherein the transport device transports the first and second substrates together to the treatment device while maintaining the substrates as opposing each other.

36. The apparatus according to claim 1, wherein the first and second substrates are adhered to each other through a photo-curing adhesive agent, and the apparatus further comprises:

a hardening device, which opposes at least one side of the first or second substrate, wherein the hardening device includes a light source for irradiating light to harden the adhesive agent; and

an irradiation sensor, which is connected to the control device, wherein the irradiation sensor measures the amount of the light irradiated to the first and second substrates;

wherein the control device controls the light source to

maintain the light irradiation amount at a constant level in accordance with the measurement of the irradiation sensor.

37. The apparatus according to claim 1, further comprising a pretreatment sub-chamber, wherein the pretreatment sub-chamber pretreats at least one of the first and second substrates under depressurization.

38. The apparatus according to claim 37, further comprising a seal applying device, wherein the seal applying device applies seal on the first or second substrate, the pretreatment sub-chamber receives the substrate on which the seal is applied, and the pretreatment includes supplying of a predetermined gas to the pretreatment sub-chamber for exposing the substrate to the gas.

39. The apparatus according to claim 37, wherein the pretreatment includes heating.

40. The apparatus according to claim 37, wherein the pretreatment includes a plasma treatment.

41. The apparatus according to claim 37, further comprising:

a seal applying device, wherein the seal applying device applies seal on at least one of the first and second substrates; and

a treatment sub-chamber, wherein the treatment sub-chamber can be depressurized and performs at least one of seal hardening, transportation of the first and second substrates to the hardening device, and separation of the bonded substrates from the first and second holding units.

42. The apparatus according to claim 1, further

comprising:

a liquid drip device, wherein the liquid drip device drips liquid on the first or second substrate; and

a measurement device, wherein the measurement device measures a drip amount of the liquid and corrects the drip amount such that a constant amount of liquid is supplied to the first or second substrate.

43. An apparatus for manufacturing a panel display, comprising:

first and second holding units, which oppose each other, wherein the first and second holding units attract first and second substrates, respectively, and each holding unit includes

a depressurization line that attracts the associated substrate through vacuum;

a treatment chamber, which accommodates the first and second holding units;

a first vacuum pump, which depressurizes the treatment chamber;

a first control valve, which is located between the treatment chamber and the first vacuum pump;

two second vacuum pumps, each of which is connected to an associated holding unit through the associated depressurization line, wherein each second vacuum pump depressurizes the associated depressurization line to attract each substrate to the associated holding unit through vacuum;

two second control valves, each of which is located between the associated holding unit and the associated second vacuum pump;

two pressure equilibration valves, each of which is located in the associated depressurization line, wherein each pressure equilibration valve connects the associated depressurization line to the vacuum chamber; and

a control device, which controls the first and second control valves, and the first and second vacuum pumps, wherein, when the vacuum chamber is depressurized, the control device opens each pressure equilibration valve to substantially equalize the pressure in the associated depressurization line with the pressure in the vacuum chamber.

44. The apparatus according to claim 43, wherein each holding unit includes another holding device for holding the associated substrate, wherein the control device instructs the another holding device to hold the associated substrate and turns off vacuum attraction of the first and second holding units.

45. The apparatus according to claim 44, wherein the another holding device includes an electrostatic chuck for electrostatically attracts the associated substrate, wherein the electrostatic chuck includes a dielectric layer that electrostatically attracts the associated substrate, an electrode embedded at a predetermined depth in the dielectric layer, and an attraction power source that applies an attraction voltage to the electrode.

46. The apparatus for manufacturing a panel display according to claim 45, wherein each pressure equilibration valve is opened when or after the attraction voltage is supplied.

47. The apparatus for manufacturing a panel display according to claim 45, wherein each holding unit includes a switching power source for supplying a separation voltage to the associated dielectric layer, and the control device lowers the attraction voltage such that the separation voltage becomes higher than the attraction voltage for separating each

substrate from the associated holding unit.

48. A method for bonding a first substrate with a second substrate in a treatment chamber, wherein the treatment chamber accommodates a first holding unit that attracts the first substrate and a second holding unit that attracts the second substrate, the method comprising the steps of:

transporting the first and second substrates as a pair to the treatment chamber;

attracting each substrate to the associated holding unit through vacuum by applying pressure to the substrate;

depressurizing the treatment chamber;

and

substantially equalizing the pressure applied to each substrate with the pressure in the treatment chamber.

49. The method according to claim 48 further comprising switching the vacuum attracting of the first and second holding units to another attracting the attracted substrates by another holding device provided in each holding unit for attracting the associated substrate.

50. The method according to claim 49, wherein the second attraction step includes electrostatically attracting each substrate to the associated holding unit.

51. The method according to claim 50, wherein the pressure equalization step is performed when or after the electrostatic attraction step is started.

52. The method according to claim 50, wherein the electrostatic attraction step includes a sub-step of applying an attraction voltage to an electrode embedded in a dielectric layer formed in each holding unit.

53. The method according to claim 52, further comprising a step of supplying a separation voltage to the dielectric layer through a conductor connected to the dielectric layer for separating the first or second substrate from the associated holding unit.

54. The method according to claim 48, further comprising a step of correcting bending of each substrate during the vacuum attraction step.

55. The method according to claim 50, further comprising:

a step of actuating the first and second holding units to align the first and second substrates after the electrostatic attraction step;

a step of actuating the first and second holding units to press the first and second substrates to each other; and

a step of controlling a pressure applied to each substrate for pressing the first and second substrates to each other.

56. The method according to claim 55, wherein the alignment step includes a sub-step of aligning an alignment mark of the first substrate with an alignment mark of the second substrate through an image of the alignment marks.

57. The method according to claim 48, wherein the first and second substrates are an array substrate that has a plurality of switch elements and a color filter substrate, and the panel display is a liquid crystal panel display.